HISTORIC AMERICAN ENGINEERING RECORD
ADDENDUM

8-FOOT HIGH-SPEED/TRANSONIC TUNNEL
BUILDING 641

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LANGLEY RESEARCH CENTER
HAMPTON, VIRGINIA

Submitted to:
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LANGLEY RESEARCH CENTER

Submitted by:
JAMES RIVER INSTITUTE FOR ARCHAEOLOGY, INC.

Date: September 2006

HISTORIC AMERICAN ENGINEERING RECORD
ADDENDUM

NASA LANGLEY RESEARCH CENTER
8-FOOT HIGH-SPEED/TRANSONIC TUNNEL

HAER No. VA-118-B

Location: 641 Thornell Road
East Area of the National Aeronautics and Space Administration's (NASA) Langley Research Center (LaRC), Hampton, Virginia

UTM Coordinates of facility center point: E380773, N4104688

The 8-Foot High-Speed/Transonic Tunnel, Facility No. 641, is adjacent to the southern branch of the Back River. The east side of the HST fronts on Thornell Avenue, a street adjacent to the river. Within a few feet to the west is the 8-Foot Transonic Pressure Tunnel (Facility No. 640). The current office building is on the east side of the tunnel structure. To the north is the Full-Scale Tunnel and to the south is a parking area. The setting of this area is characterized by large-scale wind tunnels. The administrative core of Langley Air Force Base (LAFB) surrounds the LaRC east area and features buildings of the Renaissance Revival style. Many of these buildings have architectural and historical significance and contribute to the proposed Langley Field Historic District that is potentially eligible for listing in the National Register of Historic Places. The HST is expected to fall within the boundaries of the historic district.

Date(s) of Construction: Completed in 1936

Engineer: Eastman N. Jacobs

Present Owner(s): United States Government

Present Use: Office and storage space

Significance: The 8-Foot High-Speed/Transonic Tunnel is significant at a national level for its contributions to aerospace technology. The facility was designated a National Historic Landmark in 1985.

Project Information: This documentation was prepared in February 2006, for NASA Langley Research Center under contract with Science Applications International Corporation which assists NASA in addressing environmental compliance requirements.

The document was prepared as an addendum to Level III HAER documentation completed by the National Park Service. The purpose of the addendum is to provide Level I HAER documentation in partial fulfillment of the requirements of a Programmatic Agreement among the National Aeronautics and Space Administration, the National Conference of State Historic Preservation Officers, and the Advisory Council on Historic Preservation.

The documentation was prepared with the assistance of a number of individuals including:

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CONTENTS

Historical Background[1]:

While the pioneering research conducted at Langley's wind tunnel facilities in the 1920s and early 1930s had greatly advanced the basic understanding of aerodynamics and aircraft design, the push for increasing speed capabilities opened up a new range of research questions. Aircraft that could approach or surpass the speed of sound were still years away, yet the aerodynamic difficulties encountered at high speeds were already being experienced, particularly in propeller tests. In 1927, Langley engineers built an 11-inch induction-drive high-speed wind tunnel that generated wind speeds up to 500 mph. A slightly larger 24-inch tunnel that came on stream in 1934 reached Mach 1 (the speed of sound, approximately 761 mph at sea level), but could operate only for about a minute. While these tunnels provided useful data, their size greatly limited the dimensions of test models, which in turn affected the applicability of the results to full-sized aircraft. It was clear that, in order to continue research in this field, a larger high-speed tunnel capable of sustained operation would be necessary.

Grasping that such a facility would give U.S. engineers a decided advantage in the aeronautical field, Langley's Director of Research George W. Lewis authorized the design and construction of a larger high-speed wind tunnel in 1933. The concept for the tunnel was first suggested by Eastman N. Jacobs, and key members of the design team included Russell G. Robinson and Manley J. Hood. Financed by the Works Project Administration (WPA), the facility was completed in 1936 at a cost of $266,000.

The building was made of reinforced concrete, which was relatively inexpensive and easier for the WPA laborers to work with. The complex included a 1- and 2-story combination office/shop building facing Back River, a 1-story wing at the south end that housed the entrance to the test section plenum, and a 1½-story wing to the north for the main drive motor. One problem the engineers faced in designing the tunnel was the need to counteract the Bernoulli effect. As it passed through the tunnel's narrowing nozzle, the airstream speeded up and its pressure dropped, created a partial vacuum in the vicinity of the nozzle. The test chamber thus had to be able to withstand inwardly directed atmospheric pressure. To address this, the tunnel included an igloo-shaped plenum structure around the test section with 12-inch-thick walls designed to resist external air pressure. The wind tunnel was a single-return, atmospheric, closed concrete tube shaped into a hollow, elongated ring. The interior tapered from a maximum diameter of 24 feet to 8 feet at the closed test section, hence the facility was designated the 8-Foot High Speed Tunnel (HST). The HST also included a heat-exchanger tower above the tunnel. Calculations showed that the mechanical energy of the 8,000-hp fan would be absorbed by the airstream as heat, eventually raising the temperature within the tunnel to the melting point of steel. Designed by Robinson, the ventilating tower

[1] For a more detailed historical study of the 8-Foot High Speed Wind Tunnel, see: Historic American Engineering Record (HAER). NASA Langley Research Center, Full-Scale Wind Tunnel, VA-118-B. Washington, D.C.: National Park Service, U.S. Department of the Interior, 1995.

continuously discharged a limited amount of hot air which was replaced by cool air from outside, thereby maintaining acceptable operating conditions.

Langley's 8-Foot HST was the world's first large high-speed tunnel, accommodating test models with wingspans up to 6.5 feet. An 8,000-hp fan provided a continuous air stream that, after early modifications, could achieve wind speeds up to 575 mph, 10 percent more than anticipated in the initial design. Because of the vacuum created in the test chamber during high-speed operation, the working environment was comparable to an altitude of 12,000 feet above sea level. To counteract these conditions, test personnel were housed in a special work station, wore oxygen masks, and entered and exited through an air lock.

With the onset of World War II, high-speed aerodynamic research became increasingly critical. In December 1941, shortly after test pilot Ralph Virden was killed while diving a Lockheed P-38 Lightning fighter, the HST engineers began investigating the stability-control problems of this aircraft with a 1/6th-scale model. They discovered that shock waves formed on the upper surface of the wing at around 450 mph, making it virtually impossible to recover from a steep dive, and ultimately causing the sort of massive structural failure that had doomed Virden. By March 1942, the Langley engineers had devised a solution: a flap on the lower surface of the wings that allowed sufficient lift for a pilot to pull out of steep dives. These "dive recovery flaps" would be employed on a number of U.S. aircraft including the P-38 that had prompted the tests, as well as the P-47 Thunderbolt, A-26 Invader, P-59 Airacomet (the first U.S. jet aircraft), and P-80 Shooting Star.

In December 1943, the HST's 8,000-hp motor failed. A second-stage fan was added, as well as a 16,000-hp motor, and the facility resumed operation in February 1945. With its larger motor, the HST could achieve subsonic Mach numbers up to 0.99, just shy of the speed of sound.

While the facility had played an important role in the nation's war effort, perhaps its most significant research potential would be realized in the postwar era. Early on, aeronautical engineers had recognized a significant flaw inherent in solid-walled test chambers, observing that the walls tended to suppress flow streamlines and produced deceptive aerodynamic effects. Reducing the size of aircraft models allowed for greater distance from the walls and raised the choking speed. However, this exacerbated the problem of "scale effects," as the flight characteristics of a model could not be applied to a full-sized aircraft without applying a correction factor. The use of smaller models hampered the engineers' ability to evaluate the aerodynamic characteristics of a complete airplane, such as the interference effects—or "drag penalties"—of various components such as external struts, wheels, and engine-cooling installations. Aircraft test models had to withstand large forces and the strength of available materials also limited the extent to which they could be reduced in size.

Researchers already had theorized that this interference problem might be counteracted by placing slots in the test section throat which would reduce the blockage effect caused by the tunnel walls, and some experimental configurations had been tested. However, Langley physicist Ray H. Wright was the first to engineer a practical application for this concept, which came to be known as "slotted-throat" or "slotted-wall" tunnel design. Because the introduction of slots into the design would require a proportional increase of power, Wright focused on analyzing the most efficient size of the slots to achieve zero blockage. After a tedious series of calculations, he determined that the optimal peripheral openness of the 8-Foot HST was about 12 percent, which was significantly less than earlier experimenters had expected.

Based on this work, Wright's division chief, John Stack, took up the cause of slotted-throat testing, and —despite considerable skepticism—succeeded in persuading NACA to allocate funding and personnel to the problem. The first team of researchers investigating the slotted-throat tunnel configuration began testing in the 16-Foot High Speed Tunnel early in 1947. The facility was chosen primarily because an earlier program already had been investigating blocking corrections in small, circular, "parasitic" test sections operating off the main tunnel. Initial tests in a slotted tunnel running off the 16-Foot HST produced a maximum speed just under Mach 1 (the speed of sound, approximately 761 mph at sea level) before choking. At this point, the engineers had the idea of removing the slotted-throat tunnel model from the parasitic test section and turning up the power of the driving fan. When they did, they found that the small experimental tunnel easily reached and surpassed the speed of sound. News of this finding spread quickly throughout the Langley wind tunnel community, and confirmed that the slotted wall design could produce transonic wind speeds.

Although Langley engineers were planning a new 16-foot slotted tunnel, in the interim they decided to convert the 8-Foot HST to a slotted-test-section configuration. The National Advisory Commission for Aeronautics (NACA) approved the plan in the spring of 1948, and by the end of the year the modified HST had achieved speeds in excess of Mach 1. Wright and engineers Virgil S. Ritchie and Richard Whitcomb subsequently spent seven months fine-tuning the slot design by hand in an effort to control the unacceptably turbulent and irregular airflow. Eventually they succeeded in refining the slotted-throat design until they achieved smooth transonic flow distributions, learning much about the new technology in the process.

Reconfigured with a 12-sided slotted test section, as well as new fan blades and drive train, the facility was redesignated the 8-Foot Transonic Tunnel (TT) in October 1950. In subsequent years, the 8-Foot TT would facilitate ground-breaking research in body/wing design for supersonic aircraft. Conducting tests in the tunnel in 1952, Langley scientists demonstrated that the new Convair YF-102 aircraft could not fly supersonically as predicted. Working on this problem, Whitcomb developed the "area rule" principle, which expressed that the ideal streamlined body for supersonic flight depended on a nearly uniform cross-sectional area of fuselage, wings, and tail. In practical terms, the area rule led Whitcomb to suggest a redesign of the YF-102 with a compressed, or "wasp-waisted," fuselage. The revamped YF-102A easily broke what was popularly known as the "sound barrier," and Whitcomb's once controversial area rule became crucial to the design of a number of early supersonic fighters, including the Grumman F9F-9 Tiger and the Lockheed F-104 Starfighter, the first jet to exceed Mach 2, in April 1956. With these demonstrated successes, Whitcomb's area rule achieved widespread acclaim in the scientific community and the popular press, and he was awarded the Collier Trophy for the greatest achievement in aviation in 1955.

Ultimately, the experience gained from modifying the 8-Foot TT would lead to its obsolescence, as it was superseded by the new 16-Foot Transonic Tunnel and the adjacent 8-Foot Transonic Pressure Tunnel, with which it shared some electrical facilities. The last major improvement to the 8-Foot TT came in 1957 when wood fan blades were replaced with fiber-reinforced epoxy counterparts. The TT continued in use until 1961, when it was deactivated by NASA. For the next fifteen years, the 16,000-hp motor, drive shaft, and fans were kept operational through scheduled maintenance; but in 1976 the fan blades, hub, nacelles, shaft, and turning vanes were removed and sent to Wright-Patterson Air Force Base in Ohio where they were used in the construction of a new facility in the early 1980s. Since that time, the 8-Foot TT building has been used as office and storage space. The historical significance of the facility and its many contributions to aerospace technology were recognized when it was designated a National Historic Landmark in 1985.

Chronology:

1933	NACA authorizes construction of a larger high-speed wind tunnel at Langley. The concept for the new facility is suggested by Eastman N. Jacobs, and key members of the design team include Russell G. Robinson and Manley J. Hood.
1936	Financed and built by the WPA, the 8-Foot High Speed Tunnel (HST) is completed at a cost of $266,000.
1942	Based on research in the 8-Foot HST, Langley engineers invent “dive recovery flaps” that are effectively employed in the design of a number of military aircraft.
1943	The HST’s 8,000-hp motor fails, prompting significant upgrades to the facility.
1945	The facility reopens with a new 16,000-hp motor and second-stage fan, and is now capable of test speeds up to Mach 0.99.
1948	An engineering team headed by Ray H. Wright converts the HST to a slotted-test-section configuration and spends months refining the slots to refine its transonic speed capability.
1950	With a new 12-sided slotted test section, drive train, and fan blades, the facility is redesignated the 8-Foot Transonic Tunnel (TT).
1952	Based on research on the Convair YF-102 conducted in the 8-Foot TT, Richard Whitcomb develops the “area rule,” the application of which to aircraft design facilitates supersonic flight.
1955	NACA announces the discovery of the area rule, and Whitcomb is awarded the prestigious Collier Trophy for achievement in aviation.
1957	The last major improvement to the 8-Foot TT consists of replacing the wood fan blades with fiber-reinforced epoxy counterparts.
1961	NASA deactivates the facility.
1976	The fan blades, hub, nacelles, shaft, and turning vanes are removed from the 8-Foot TT and used in the construction of a new facility at Wright-Patterson Air Force Base in Ohio.

1985 The historical significance of the facility and its many contributions to aerospace technology are recognized by its designation as a National Historic Landmark.

Sources Consulted:

Baals, Donald D. and William R. Corliss. *Wind Tunnels of NASA*. Washington, D.C.: National Aeronautics and Space Administration, 1981.

Butowsky, Harry A. *Man in Space: National Historic Landmark Theme Study*. Washington, D.C.: National Park Service, Department of the Interior, 1984.

Butowsky, Harry A. National Register of Historic Places Inventory-Nomination Form, Eight-Foot High Speed Tunnel. Washington, D.C.: National Park Service, Department of the Interior, 1984.

Historic American Engineering Record (HAER). NASA Langley Research Center, 8-Foot High Speed Wind Tunnel, VA-118-B. Washington, D.C.: National Park Service, U.S. Department of the Interior, 1995.

National Advisory Committee for Aeronautics (NACA). Characteristics of Nine Research Wind Tunnels of the Langley Aeronautical Laboratory. Washington, D.C.: NACA, 1957.

Physical Description:

Four structures compose the current TT; the original concrete tunnel circuit, the original motor building, an electrical equipment building addition, and a replacement two story office building. The facility began operations in 1936.

The HST is a single-return atmospheric pressure tunnel with an 8-foot diameter closed-throat test section. Constructed of 12-inch-thick reinforced concrete, it is a tubular-shaped horizontal structure. In plan it forms an elongated rectangle with overall dimensions of 165 feet (north–south) by 59 feet (east–west) by 29 feet high. The tunnel structure occupies a ground area of 9,700 square feet and has a volume of 270,000 cubic feet. The interior diameter of the tunnel tapers from 24 feet at its maximum to 8 feet at the test chamber. The test chamber is located on the centerline of the tunnel at approximately the mid-point of its south side and is enclosed in a 42-foot-diameter igloo, or beehive-shaped, reinforced concrete structure. An airlock between the igloo and the adjacent office building provided access to the tunnel. The test section, test conditions, the model support system, models, and test instrumentation are described in detail in an Appendix to the 1995 Historic American Engineering Record for this facility. Driven originally by a 16-foot-diameter, 18-blade fan, the airflow in the tunnel moved in a counter-clockwise direction. An 8,000-hp Crocker-Wheeler motor in the adjacent motor house powered the fan. The fan was centered in the air stream and positioned near the motor house at the northeast corner of the tunnel. Turning vanes were placed in the air stream at each of the four corners of the tunnel. Straddling the tunnel near its southwest corner is a tall concrete ventilation house (heat exchanger) that features movable and fixed vanes to modulate airflow and concrete ducts extending to the top of the structure. The top of the ventilation house was originally fitted with large louvers. The motor house was located immediately to the north of the tunnel. Its floor area was approximately 1,850 square feet. The motor was located in the southwest corner of the motor house on axis with the fan.

Modifications of the tunnel included replacement of the 8,000-hp fan motor in 1945 with a 16,000-horsepower motor and the addition of a second stage fan. At that time a Kramer speed control system was added and housed in a new two-story Electrical Equipment Building that was built behind the main drive motor house (on the west side). A projecting penthouse with large louvers on each face was added to the ventilation house. The date of the penthouse addition has not been discovered but it is believed to have occurred about the time that the 16,000-horsepower motor was added since the new motor produced more heat and additional ventilation would have been required. In 1944 a center-plate model support was developed and installed to reduce blockage of airflow. The center-plate support proved to be ineffective for performance testing of wing and body configurations of complete aircraft. These limitations were overcome in 1946 by the introduction of a “sting” support system. In 1948 one of the most significant changes was conversion of the test section to incorporate a slotted throat configuration. The slotted-throat design would lead to discoveries of the area rule for design of supersonic aircraft. In 1950 the tunnel was again reconfigured with the installation of a 12-sided slotted test section, and the fan blades and drive train were replaced. This modification was limited by the desire to keep the original concrete tunnel intact. The length available for the test section was restricted to 15 feet by the geometry of the existing entrance cone and the upstream end of the diffuser. The cross sectional area at the throat had to be reduced to less than the diffuser entrance. To accomplish this reduction a liner was inserted into the original tunnel. The liner was made with 12 sides to simplify construction and to provide plane surfaces for windows. The igloo shaped test chamber was used as a sealed plenum surrounding the slots. Glass observation ports were provided in the top and side of the test chamber and in the chamber door. After these conversions the tunnel was redesignated the 8-foot Transonic Tunnel. In December of 1960 the tunnel was deactivated, and in 1976 the fan blades, hub, nacelle, shaft and turning vanes were removed and sent for use in a new facility at Wright Patterson Air Force Base.

The initial construction project included an office and shop building that was a 1-and 2-story, 4-bay wide by 3-bay deep, art deco design with fluted pilasters. It was sited on the east side of the tunnel. The front faced north and the one story element at the south end adjoined the igloo-shaped test chamber. The two-story portion of the building was 52-feet long, 23.5-feet wide, and 29-feet tall; its ground floor covered approximately 12,000 square feet and its volume was 35,000 cubic feet. The one story portion projected 15 feet to the south. A room at the north end of the second floor occupied one bay and was designated as private offices. The two bays at the south end of the second floor provided an open office space. The first floor, with the exception of a toilet and shower space in the back, was open shop space. There was a single interior stair in the northeast corner. A 1942 written description reports that the exterior walls were “hollow tile stuccoed”, the floors “7-inch thick concrete”, and the roof “built up on “Gypsteel” gypsum plank”. Original drawing notes indicate that the floors were supported on “Havermeyer steel joists, #124 – 21½ (depth in inches)” on 14-inch centers between I beams. Cast iron downspouts were contained within the walls. The first floor shop walls were “painted smooth tile” with the ceiling “exposed alum (inum) paint”. The second floor office (south end of building) had linoleum floors; walls and ceiling were "Plaster on Celotex." The partition between this room and the northern room was "Gypsteel Senior Plank" 2" x 15" x 10'-0" (or equal) plastered both sides". The partition had two steel frame windows and a door. The north room of the second floor had a cement floor, walls of "rigid tile" and a ceiling with "exposed alum paint". Windows in the exterior wall were steel and a nameplate over the main door was of limestone. The first floor was above a crawl space and the concrete foundation was supported on 12-ton piles.

Changes in office facilities at the HST included an addition to the original office/shop building that appears by 1943. A NASA drawing shows that it was a two story clapboard wooden temporary wing built on the south end of the original art deco building. It was 61 feet 9 inches long (north-south) by 22 feet 5 inches wide (east-west) and was connected to the original building by a narrow link enclosing a stair. In 1966 the original building and the addition were replaced by a two story stuccoed office building of a plain design. The new office contained approximately 21,000 square feet and was extensively renovated in 1985.

With the exception of the office replacement and removal of tunnel equipment for use at another facility, the HST retains design integrity. The 8-Foot High Speed Tunnel was designated a National Historic Landmark in 1985.

Description from "Man in Space, A National Historic Landmark Theme Study"

The following description of the Eight-Foot High Speed Tunnel is copied from "Man in Space, A National Historic Landmark Theme Study". It is included in this document because it describes some of the issues that had to be addressed in the tunnel's design.

The Eight-Foot High Speed Tunnel is a single-return atmospheric pressure tunnel with an 8-foot diameter closed-throat test section. The tunnel became operational in 1936 and at that time had a maximum speed of Mach 0.75 driven by an 8,000-horsepower electric motor/fan.

The design of the Eight Foot High Speed Tunnel was complicated by two problems. [1]

The first problem involved the effect discovered in 1738 by the Swiss mathematician Daniel Bernoulli who observed that as the velocity of flow in a duct is increased by constricting the cross sectional area, the static pressure of the fluid drops. In wind tunnel design, this means that the air pressure in the chamber containing the high-velocity test section will be lower than in the rest of the tunnel. Thus, for the tunnel, the test chamber had to withstand a powerful, inwardly directed pressure. [2]

One method to solve this problem would have been to construct a welded steel pressure vessel around the test section. In an effort to solve the pressing unemployment problem then existing as a result of the Depression, NACA engineers decided to use locally available unskilled labor and build the entire tunnel of reinforced concrete. An igloo-like structure around the test sections was built with walls 1 foot thick. The igloo was essentially a low pressure chamber—just the opposite of the VDT. Operating personnel in the igloo were subjected to pressures that were the equivalent of 10,000 feet altitude (sic) *and had to wear oxygen masks and enter through airlocks. [3]*

The second new problem that was created had to do with the mechanical energy that the 8,000-horsepower fan added to the airstream. NACA engineers calculated that this additional heat would cause the temperature within the tunnel to rise ten degrees per second until it reached the stage at which the amount of heat seeping through the concrete walls would equal the input of heat from the fan. Before this would happen the temperature within the tunnel would reach several thousand degrees.

The task of providing a cooling system was given to Russell G. Robinson who devised a ventilating tower that periodically allowed a small amount of heated air to escape in exchange for fresh cool air. This system proved to be successful and was accomplished with a loss of only one percent of power. This same principle was later applied to many other high speed tunnels. [4]

The Eight-Foot High Speed Tunnel was repowered in 1945 to 16,000-horsepower. By 1950 a slotted throat design was added to the test section that enabled the tunnel to be operated as a transonic tunnel. In 1953 the tunnel was repowered to 25,000-horsepower to yield a speed of Mach 1.2. A schlieren apparatus was also added to the test section of the tunnel to increase the capability for visual flow studies.

The Eight-Foot High Speed Tunnel was deactivated in 1956 (sic) *and is now abandoned in place. The original test section of the tunnel is used for storage.*

1. Much of the material in Section 7 and 8 of this report has been adapted from Donald D. Baals and William R. Corliss, Wind Tunnels of NASA (Washington, D.C.: National Aeronautics and Space Administration, 1981), pp. 25-8.

2. Ibid., 25.

3. Ibid., 26.

4. George W. Gray, Frontiers of Flight: The Story of NACA Research (New York: Alfred A. Knopf, 1948). pp. 42-43.

HISTORIC AMERICAN ENGINEERING RECORD
ADDENDUM

INDEX TO PHOTOGRAPHS

NASA LANGLEY RESEARCH CENTER HAER NO. VA-118-B
8-FOOT HIGH-SPEED/TRANSONIC TUNNEL
Hampton
Virginia

Chris Cunningham, photographer, March 2006

VA-118-B-23	Photocopy of photograph (original in Langley Research Center Archives, Hampton, Virginia [LaRC] (NACA 11861) AERIAL VIEW OF 8-FOOT HIGH-SPEED/TRANSONIC TUNNEL CA. 1936.
VA-118-B-24	Photocopy of photograph (original in Langley Research Center Archives, Hampton, Virginia [LaRC] (EL-1999-00632) CLOSE UP OF 8-FOOT HIGH-SPEED/TRANSONIC TUNNEL TEST CELL MOTOR CA. 1936.
VA-118-B-25	Photocopy of photograph (original in Langley Research Center Archives, Hampton, Virginia [LaRC] (EL-1999-00633) FULL VIEW OF 8-FOOT HIGH-SPEED/TRANSONIC TUNNEL TEST CELL CA. 1936.
VA-118-B-26	Photocopy of photograph (original in Langley Research Center Archives, Hampton, Virginia [LaRC] (EL-1999-00634) PRE-SUPERSONIC 8-FOOT HIGH-SPEED/TRANSONIC TUNNEL TEST CELL INTERIOR CA. 1936.
VA-118-B-27	Photocopy of photograph (original in Langley Research Center Archives, Hampton, Virginia [LaRC] (EL-1999-00280) SUPERSONIC 8-FOOT HIGH-SPEED/TRANSONIC TUNNEL TEST CELL INTERIOR CA. 1957.
VA-118-B-28	Photocopy of photograph (original in Langley Research Center Archives, Hampton, Virginia [LaRC] (NACA 12467) 8-FOOT HIGH-SPEED/TRANSONIC TUNNEL FAN BLADES.

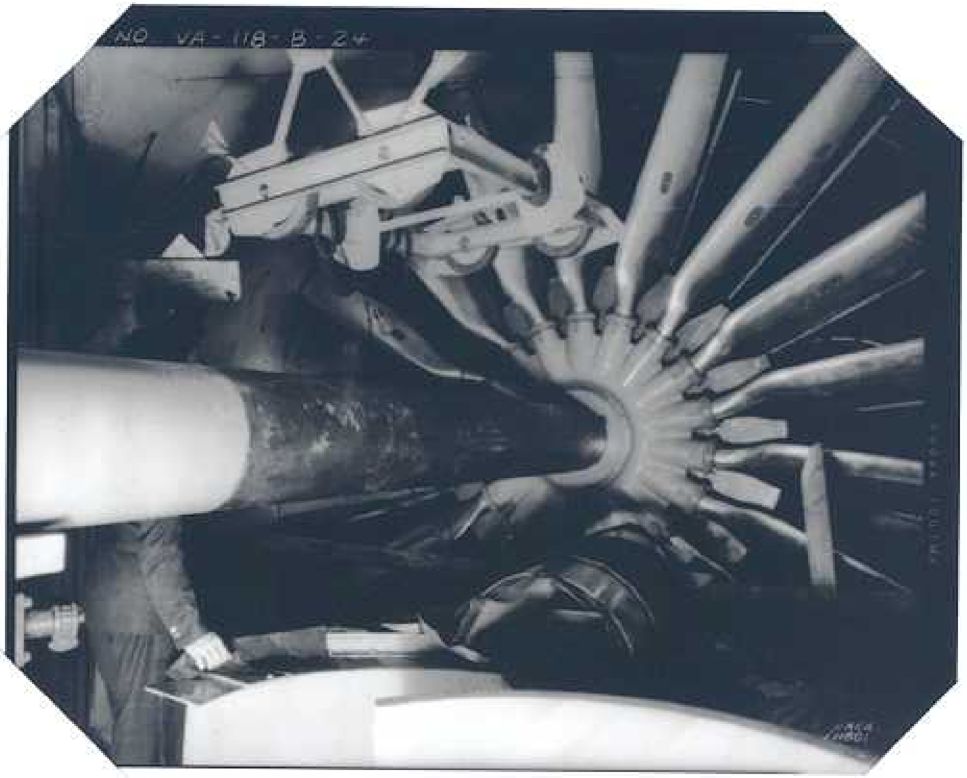
VA-118-B-29	Photocopy of photograph (original in Langley Research Center Archives, Hampton, Virginia [LaRC] (EL-2000-00278) 8-FOOT HIGH-SPEED/TRANSONIC TUNNEL CONTROL DESK CA. 1953.
VA-118-B-30	VIEW LOOKING NORTH AT SOUTH END OF 8-FOOT HIGH-SPEED TRANSONIC TUNNEL. GALLERY ABOVE TUNNEL IS FOR AIR INTAKE IN AIR EXCHANGE TOWER.
VA-118-B-31	VIEW LOOKING WEST AT SOUTH END OF 8-FOOT HIGH-SPEED TRANSONIC TUNNEL WITH FACILITY AIR EXCHANGE TOWER. (MOTOR HOUSE AT LEFT OF VIEW POWERS 8-FOOT TRANSONIC PRESSURE TUNNEL IN BACKGROUND – BUILDING 640.)

HISTORIC AMERICAN ENGINEERING RECORD
SEE INDEX TO PHOTOGRAPHS FOR CAPTION

HAER NO. VA-118-B-23

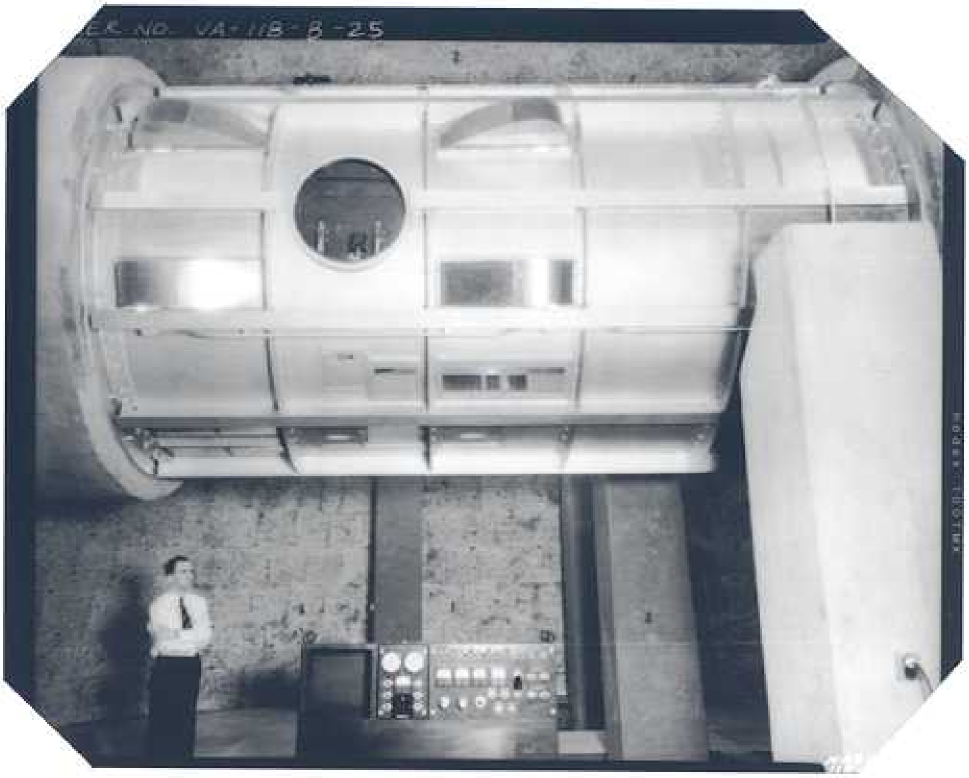
HISTORIC AMERICAN ENGINEERING RECORD
SEE INDEX TO PHOTOGRAPHS FOR CAPTION

HAER NO. VA-118-B-24



HISTORIC AMERICAN ENGINEERING RECORD
SEE INDEX TO PHOTOGRAPHS FOR CAPTION

HAER NO. VA-118-B-25



HISTORIC AMERICAN ENGINEERING RECORD
SEE INDEX TO PHOTOGRAPHS FOR CAPTION

HAER NO. VA-118-B-26

HISTORIC AMERICAN ENGINEERING RECORD
SEE INDEX TO PHOTOGRAPHS FOR CAPTION

HAER NO. VA-118-B-27

HISTORIC AMERICAN ENGINEERING RECORD
SEE INDEX TO PHOTOGRAPHS FOR CAPTION

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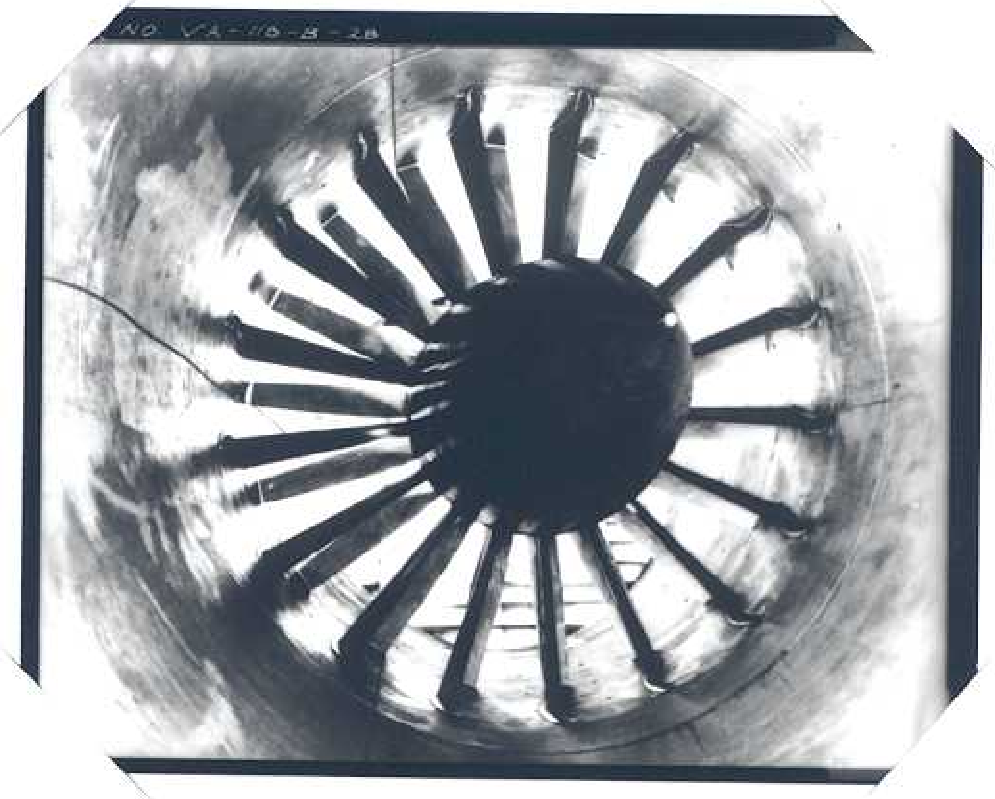


HISTORIC AMERICAN ENGINEERING RECORD
SEE INDEX TO PHOTOGRAPHS FOR CAPTION

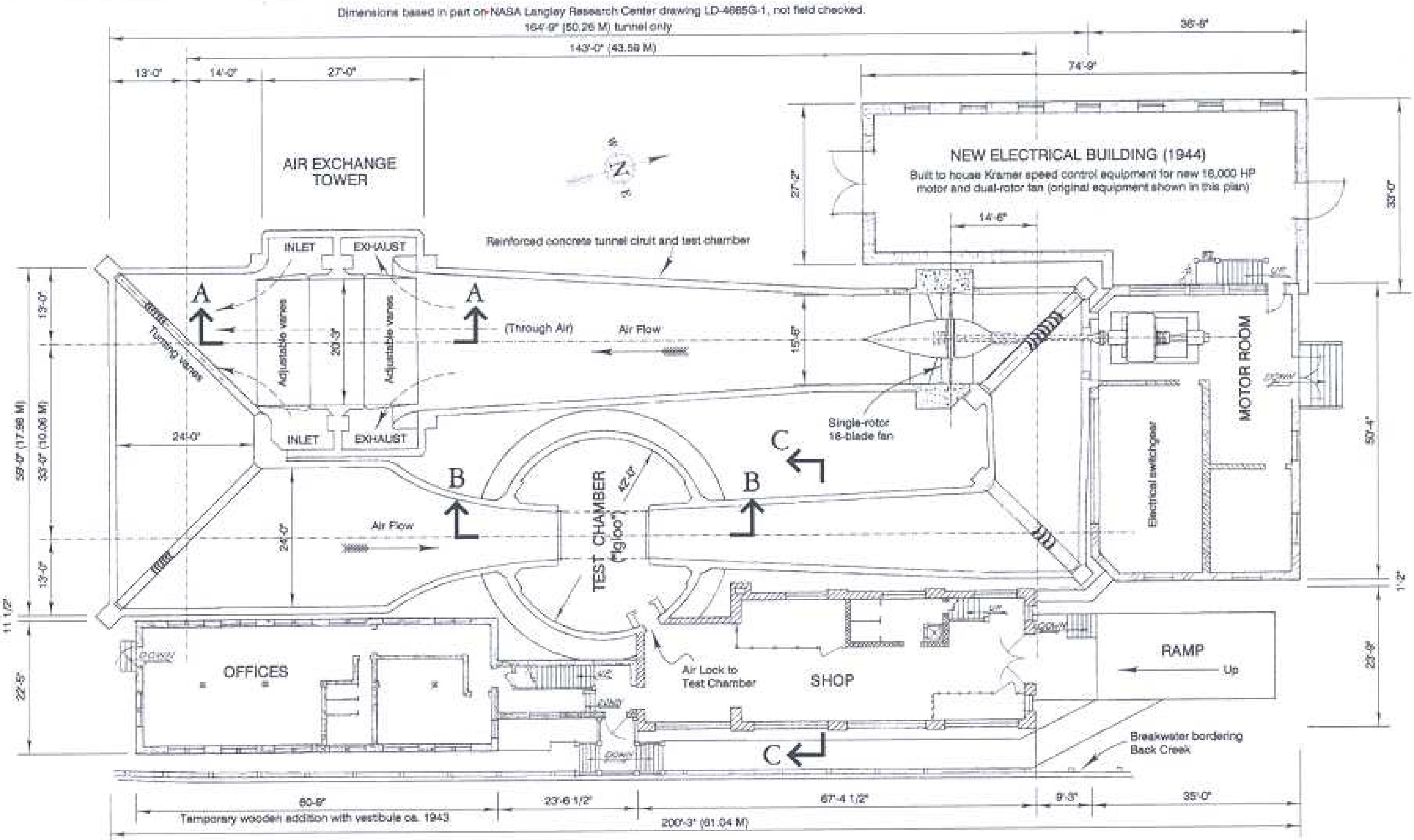
HAER NO. VA-118-B-29

HISTORIC AMERICAN ENGINEERING RECORD
SEE INDEX TO PHOTOGRAPHS FOR CAPTION

HAER NO. VA-118-B-30

HISTORIC AMERICAN ENGINEERING RECORD
SEE INDEX TO PHOTOGRAPHS FOR CAPTION

HAER NO. VA-118-B-31



FIRST FLOOR PLAN (ca. 1944)

Scale: 1/8" = 1'-0" (1:96)

0 10 20 30 40 50 60 70 80 90 100 Feet

0 5 10 15 20 25 30 Meters

Adapted from NASA Langley Research Center drawing LD-4665-G1, "8-Ft. High Speed Wind Tunnel, General Arrangement," December 1934 and LD-13899-9 "8'-0" High Speed Offices and Electrical Equipment Buildings" December 1943; original labeling was removed for clarity.

This plan shows the facility when its original subsonic test cell was in use. Other additions and modifications occurred to systems and internal functions which are not shown here. Sheet 4 shows the tunnel and major equipment at the time it was equipped with the first supersonic test cell. See the HAER data pages and large format photos for further information.

DELINEATED BY: Richard K. Anderson, Jr., 2006.

NASA LANGLEY RESEARCH CENTER RECORDING PROJECT

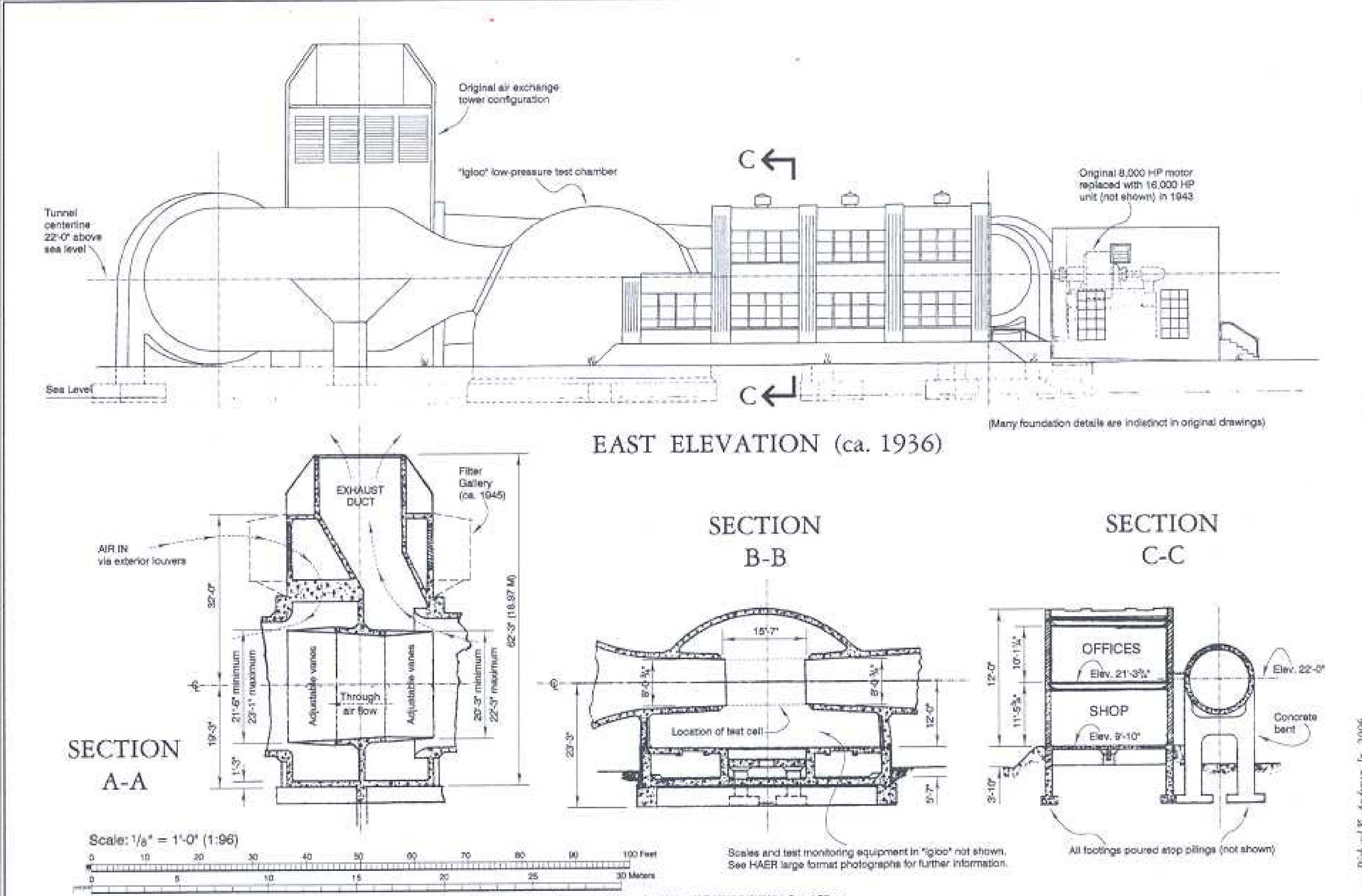
ADDENDUM to 8-FOOT HIGH SPEED WIND TUNNEL (1936)

HAMPTON — VIRGINIA

SHEET 1 - 4

HISTORIC AMERICAN ENGINEERING RECORD

VA-118-B



Elevation adapted from NASA Langley Research Center drawing LD-4665-G1, "8-Ft. High Speed Wind Tunnel, General Arrangement," December 1934 and LD-13899-9 "8'-0" High Speed Offices and Electrical Equipment Buildings" December 1943; sections adapted from D-5706, "Plans and Sections," ca. 19447; original labeling was removed for clarity from all drawing portions displayed here.

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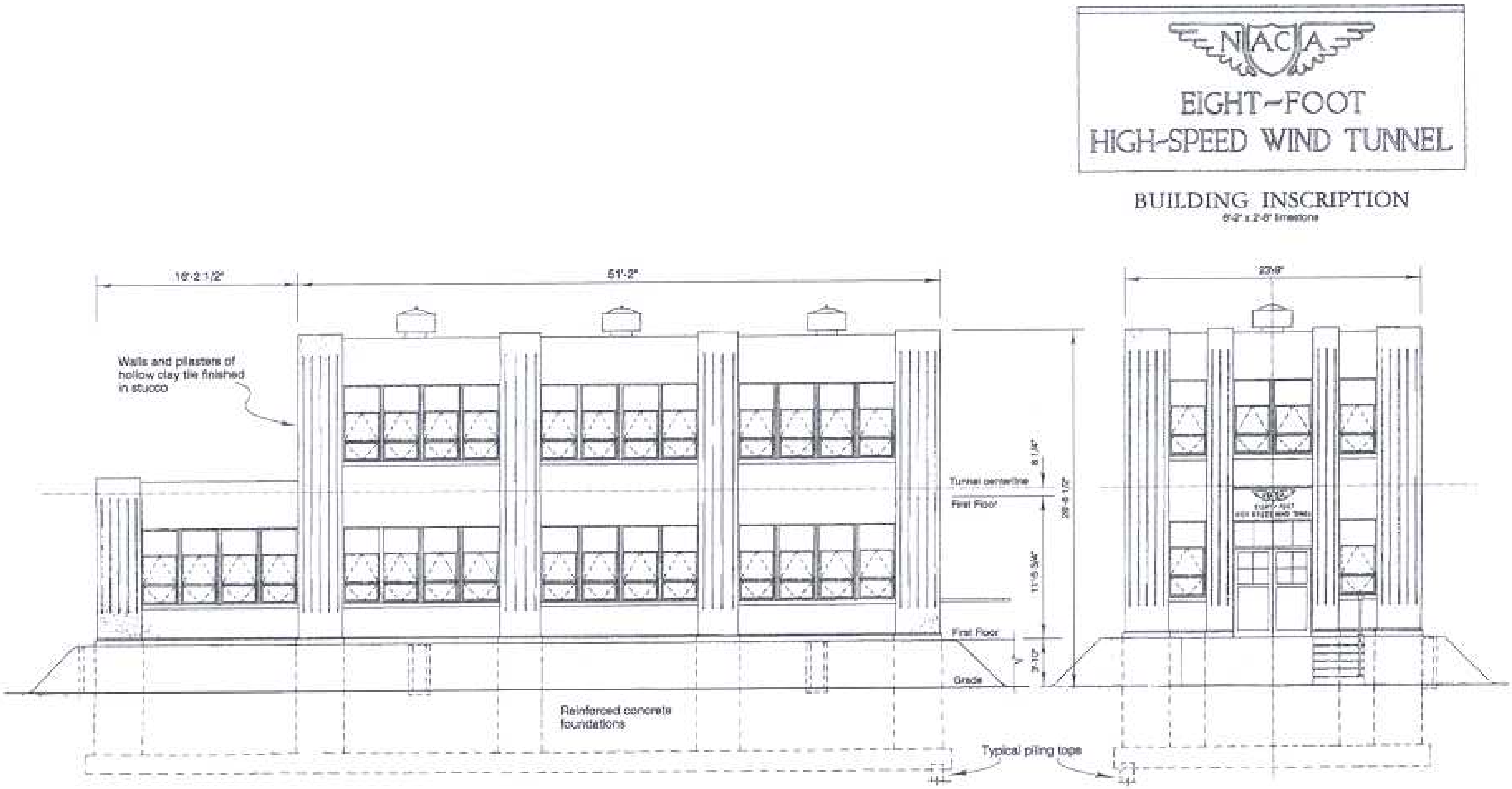
NASA LANGLEY RESEARCH CENTER RECORDING PROJECT
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

ADDENDUM to 8-FOOT HIGH SPEED WIND TUNNEL (1936)
BUILDING 641, 641 THORNELL AVENUE
HAMPTON
HAMPTON VIRGINIA

SHEET 2 - 4

HISTORIC AMERICAN ENGINEERING RECORD
VA-118-B



EAST ELEVATION (ca. 1936) SHOP and OFFICE BUILDING

NORTH ELEVATION

Scale: 1/4" = 1'-0" (1:48)

0 10 20 30 40 50 60 70 80 90 100 Feet

0 5 10 15 20 25 30 Meters

Based on NASA Langley Research Center drawing LD-4673-1, "8-Ft. High Speed Wind Tunnel, Office & Shop Elevations," December 1934; building inscription from LD-4673-5 "8-Ft. High Speed Wind Tunnel, Office & Shop [Foundations & Pilings]" December 1934. Original labeling was removed for clarity; window details were filled in from existing instances for a more complete architectural effect; west and south elevations are of similar architectural character. In the 1970s, the Art Deco pilasters and details were removed and the walls stuccoed for a more modern appearance. See HAER large format photos for details.

Richard K. Anderson, Jr., 2006.

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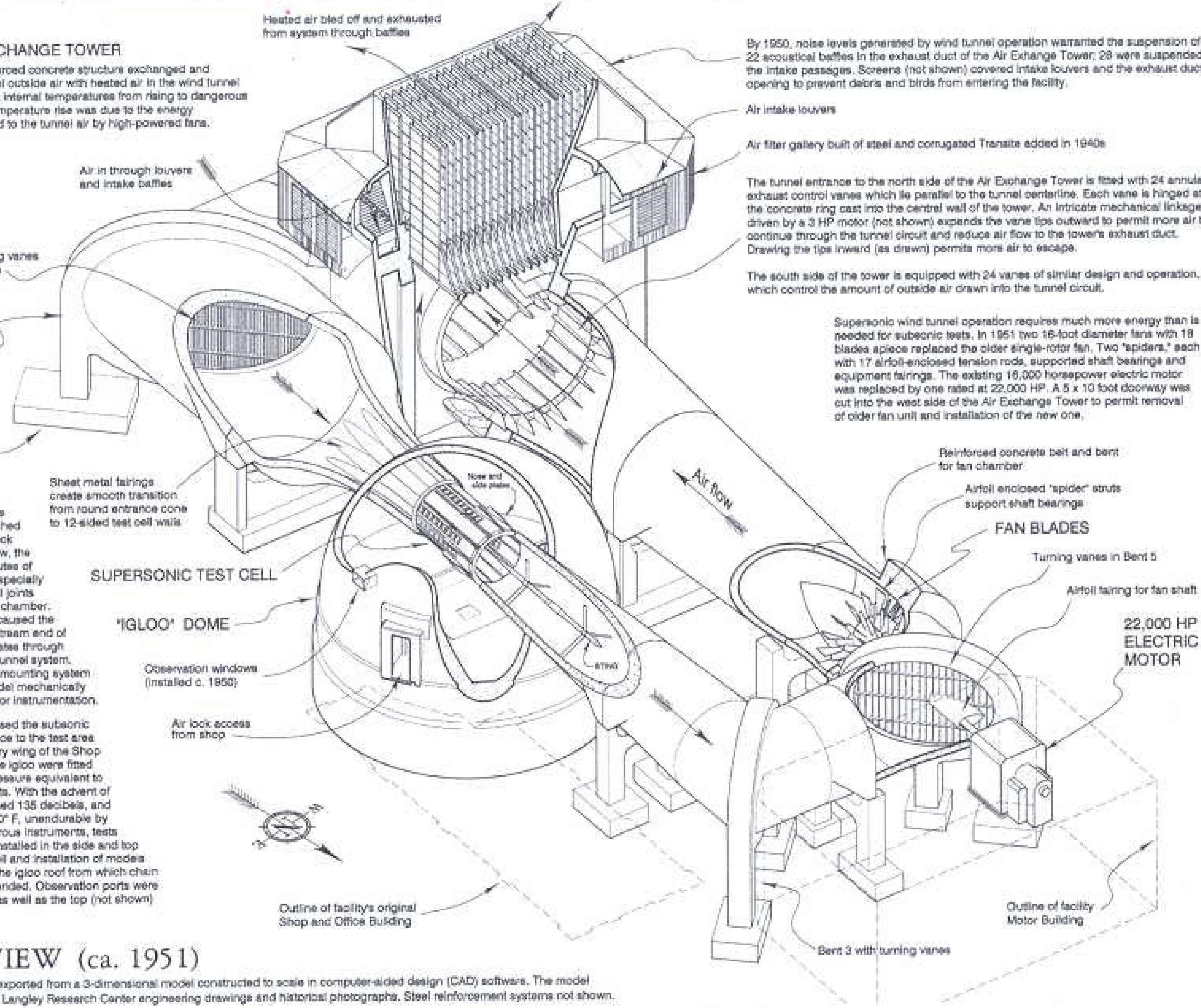
HAMPTON | VIRGINIA

SHEET 3 - 4

HISTORIC AMERICAN ENGINEERING RECORD VA-118-B



AIR EXCHANGE TOWER

This reinforced concrete structure exchanged and mixed cool outside air with heated air in the wind tunnel to prevent internal temperatures from rising to dangerous levels. Temperature rise was due to the energy transferred to the tunnel air by high-powered fans.

By 1950, noise levels generated by wind tunnel operation warranted the suspension of 22 acoustical baffles in the exhaust duct of the Air Exhange Tower; 28 were suspended in the intake passages. Screens (not shown) covered intake louvers and the exhaust duct opening to prevent debris and birds from entering the facility.

The tunnel entrance to the north side of the Air Exchange Tower is fitted with 24 annular exhaust control vanes which lie parallel to the tunnel centerline. Each vane is hinged at the concrete ring cast into the central wall of the tower. An intricate mechanical linkage driven by a 3 HP motor (not shown) expands the vane tips outward to permit more air to continue through the tunnel circuit and reduce air flow to the tower's exhaust duct. Drawing the tips inward (as drawn) permits more air to escape.

The south side of the tower is equipped with 24 vanes of similar design and operation, which control the amount of outside air drawn into the tunnel circuit.

Supersonic wind tunnel operation requires much more energy than is needed for subsonic tests. In 1951 two 16-foot diameter fans with 18 blades apiece replaced the older single-rotor fan. Two "spiders," each with 17 airfoil-enclosed tension rods, supported shaft bearings and equipment fairings. The existing 16,000 horsepower electric motor was replaced by one rated at 22,000 HP. A 5 x 10 foot doorway was cut into the west side of the Air Exchange Tower to permit removal of older fan unit and installation of the new one.

The supersonic test cell had twelve 1/2" thick steel walls whose surfaces and window joints were highly polished to avoid the production of stray shock waves. To induce supersonic air flow, the walls diverged at an angle of 5 minutes of arc from the tunnel centerline, and specially tapered slots at the longitudinal wall joints allowed air to escape into the igloo chamber. The resulting lowered air pressure caused the air speed to increase. At the downstream end of each slot were a "nose" and side plates through which air was drawn back into the tunnel system. A concentrically suspended model mounting system called a "sting" supported each model mechanically and provided various connections for instrumentation.

The reinforced concrete "igloo" housed the subsonic test cell and operating crew. Entrance to the test area was by an air lock from the one-story wing of the Shop and Office Building. Personnel in the igloo were fitted with pressure suits to work in air pressure equivalent to an altitude of 12,000 feet during tests. With the advent of supersonic tests, noise levels reached 135 decibels, and internal air temperatures rose to 160° F, unendurable by human beings. In addition to numerous instruments, tests were monitored through windows installed in the side and top of the test cells. Work on the test cell and installation of models was aided by steel loops cast into the igloo roof from which chain falls and other tools could be suspended. Observation ports were cut into the south side of the igloo as well as the top (not shown) after supersonic tests began.

CUTAWAY VIEW (ca. 1951)

No scale displayed. Cutaway view exported from a 3-dimensional model constructed to scale in computer-aided design (CAD) software. The model was based on several dozen NASA Langley Research Center engineering drawings and historical photographs. Steel reinforcement systems not shown.

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SHEET 4 - 4

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